Climate perceptions, impacts and responses: a synthesis of lessons from eight African countries

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Contributors

Mekonnen Adnew Degefu
Casim Umba Tolo
Francis Opiyo
Grace Mudombi-Rusinamhodzi
Makula Pauline
Amidu Owolabi Ayeni
Georges Djohy
Sarah Tanson Nicole
Comlan Médard Ouinakonha
Yanon Galiné

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1.0 Introduction

Studies show that global climate change and variability is accelerating and that its impacts will strongly affect the African continent, which will be an additional challenge for future development (Huq et al., 2004; Haile, 2005; Kurukulasuriya and Mendelsohn, 2006; Adger et al., 2007; IPCC, 2007). It is projected that the African climate will generally become warmer and drier (IPCC, 2007) with possibly more intense extreme events including droughts, storms and floods (IPCC, 2012). The current paper is a synthesis of research undertaken by recipients of ACCFP fellowship awards. Each researcher investigated climate change adaptation in rural settings with differing research questions in Ethiopia, Kenya, Tanzania, Uganda, Senegal, Benin, Nigeria and Zimbabwe (see box 1).

The paper begins with an overview of impacts of the interaction of climate change with other drivers of change, and then compares perceptions of changes with observational records. Existing responses, including those based on indigenous knowledge systems (IKS) are then examined, as well as the factors that determine accessibility of responses. The paper concludes with recommended activities to support adaptation.

Box 1: Case study contexts and aims

Ethiopia case study

The research in Ethiopia aimed to analyse the variability and trends of drought and flood events in the Omo-Ghibe Basin, and to assess the local adaptation practices among the pastoral communities. The lower part of the Omo-Ghibe basin is inhabited by the pastoral marginalised communities of Hammer, Dasenech, Nyangatom, Arbore, Ari, Mursi, Bena, Tsemay, and many others who lead pastoral and agro-pastoral economic activities. For a long period of time, they are highly marginalized in all social, economic and political services by the central government. In this region, both drought and flood hazards are the common and growing environmental problems. The lower part of the basin is known for its frequent droughts and floods. The intensity and frequency of severe drought and flood events increased during the last few decades. The 2006 flood hazard alone killed over 364 people and 3000 livestock and displaced over 15,000 people in 14 villages in the lower Omo basin. Apart from direct loss of life and property, the occurrence of flood and drought caused conflicts between Hammer, Dasenech, Nyangatom, Surma, Erbore, Borena, Konso in Ethiopia and Turkana in Kenya (Adnew and Asfaw, 2006; Amsalu and Adem, 2009).

Kenya case study

The Kenyan case study aimed at understanding how pastoralists perceive and have responded to past climatic change in order to inform how to support current and future adaptation strategies. The case study was conducted in Turkana County, part of the Arid and Semi-Arid Lands (ASALs) in North-western Kenya that covers an areas of 77,000 Km² in size. The study area is hot and dry throughout most of the year and is characterised by seasonal and bimodal rainfall distribution with high temporal and spatial variability between seasons and years. Annual mean temperatures experienced in Turkana range between 26 ºC and 38ºC (Government of Kenya, 2008). The Turkana livestock keepers are known to be highly mobile with no fixed residence or regular pattern of movement. The livestock species kept (camels, cattle, sheep, goats and donkeys) have different forage and water requirements and variable levels of resilience during drought periods. Despite being home to approximately 14 million pastoralists, little has been done to address the threats of climate change to livestock systems. Sites selected in Kakuma, Lokichoggio and Oropoi divisions for this study are located in the arid zones where long-term average rainfall is less than 250 mm per year.

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2.0 Multiple livelihood stresses

The effects of climate change over Africa will be even more severe due to the existing, complex, socio-economic and environmental problems that have reduced the adaptive capacity of the continent. Traditional factors such as land use changes, especially conversion of farmland to urban landuses, excessive take up and over grazing affects pastoralism negatively (MEHU, 2011; Garba, 2012). The lack of diversified sources of household income, limited livestock marketing opportunities, changing land tenure and unclear property right regimes, and the breakdown of traditional social and resource governance institutions work in concert to weaken pastoral resilience against otherwise "normal" climatic variability as shown by large scale livestock losses during droughts (Nkedianye et al., 2011; (Bryan et al., 2013).The impacts of climate change need to be understood and adapted to in the context of multiple stressors (Eakin, 2005; Reid and Vogel, 2006; Ziervogel and Taylor, 2008; Eriksen and Silva, 2009).

The first step to confronting the impacts of climate change is awareness that it is happening and knowledge of the impact it is having. Successful interventions need to build on the above and on what people are already doing to cope and/ or adapt. Therefore the next sections look first at the evidence arising from the case studies of communities' perceptions of climate change and its impacts. The paper then goes on to outline the coping and/ or adaptation strategies already employed by the communities in the case studies.

3.0 Perceptions of climate change

Climate change has been observed by pastoralists in Kenya, Ethiopia and Tanzania. Increasing temperatures and increased variability in rainfall were noticed in all three examples. In Kenya 42.1% of the respondents perceived rainfall amounts as decreasing with shortened seasons which are widely spaced. 96.8% of respondents reported that the number of rainy days had decreased, and rainfall had become more erratic and 63.6% reported variability within seasons. In both Tanzanian communities (Ibohora

and Ikuvala) decreasing rainfall amounts were experienced, and the onset of the rain/growing season was noted to be increasingly unpredictable and in most cases starting late – although a greater proportion (97%) of Ibohora farmers were aware of significant changes compared to 44% in Ikuvula (which is a drier context anyway). Increasing frequency of drought was also observed in Kenya, Tanzania, and Ethiopia. 87.9% of the sample in Kenya mentioned increased severity of drought in the study area over the last 30 years, whilst in Ethiopia the majority of the household heads (over 70% of the respondents) identified drought as a major climate related hazards in their region.

The above perceptions match observational records for temperature increase (Ogutu et al., 2007) and rainfall (Rao et al., 2011) in Kenya and Tanzania, although in Ethiopia the perceived decline in rainfall amount is not supported by the meteorological rainfall data records (Meze-Hausken, 2004; Bewket and Alemu, 2011; Bewket, 2012). Similarly, in Ethiopia, analysis of drought events shows a decreasing trend for the last three decades – although this does not take into account the distribution of the rainfall and rainy days during the growing season. Since the timing of rain is a very important factor for pasture and crop growth, decreased rainfall during these period may lead farmers to perceive that that droughts are increasing.

Perceptions of change among pastoral communities were mirrored in the groundnut-growing district of Bambey in Senegal. This area has always been one of high inter-annual variability, but observational records from the period 1947 to 2010 show that there have been increasing periods of drought, such that since 1968 the entire Sahel region has grown from a wetter to a drier region. These changes are confirmed by the memories of farmers, with 58% of respondents agreeing the rainy season was getting drier and 80% recognising it is getting shorter in duration. 90% cite drought as the major climatic risk. The dynamics of rainfall within the rainy season have also changed. Several studies have already been conducted in sub-Saharan Africa with the aim to develop methods and criteria for analysis of start and end of the rainy season (Guéye and Sivakumar, 1992; Somé and Siva

kumar, 1994; Balme et al., 2005; Sarr et al, 2011). Applies to Bambey, it shows that the average length of rainy season is 92 days, but with a year-to-year variation of between 30 and 167 days. The highest risk of 7 day droughts is in May, reducing into June and reducing further into July.

Tanzania case study

The Tanzanian case study was undertaken in the Great Ruaha River sub-Basin (GRRB) in south-western Tanzania and examines the vulnerability, resilience and adaptation of farmers to stresses including climate change and variability. The study also assesses the contributing role of the wide range of other socio-economic drivers that might influence decision making processes The climatic conditions that exist in the basin vary widely from semi-arid in the area north of the Poroto and Udzungwa mountains, increased rainfall southwards, with up to 1,800 mm of rainfall measured on the slopes of the Udzungwa and Kipengere ranges. Runoff patterns in the GRRB are closely related to the rainfall pattern. Most rivers start rising in December, with a peak in March to April (SMUWC, 2001). Three villages located in three agro-ecological areas in the GRRB, south-western Tanzania, make up the sites for this study, enabling analysis of different levels of vulnerability, coping and adaptation strategies to be investigated. The sites were purposively selected based on available information from past studies, which thus permits building on existing knowledge and making comparisons. The first village (Iboho-ra) is upstream of the Great Ruaha River (Usangu plains) where rice farming is predominant; the second village (Ikuvala) is located in midlands region of the river (highlands) where maize and tomatoes are priority crops, and the third village (Ruaha Mbuyuni) is in the downstream region of the river where mostly onions and rice are cultivated.

Uganda case study

Over the last decades, Lake Victoria and its basin have undergone major environmental changes that have resulted in rapid reduction in its natural resources, eutrophication and significant drop in the water levels (Verschuren et al., 2002; Sida, 2004; Lejju, 2012). Climate change, population increase, and demand for land for agriculture, urbanisation and industrial uses will exacerbate the challenges in the coming years (Odada et al., 2004).The study was conducted in Rakai and Isingiro districts in the Lake Victoria basin. Both districts are typical of the setting with dependence on natural resources to meet basic needs. The aim of the research was to investigate and document local and indigenous knowledge systems used in subsistence agriculture to enhance climate risk management and mitigation of community vulnerability in a changing climate and promoting livelihoods securiity-for vulnerable communities.

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4.0 Observed impacts of climate change

In Ethiopia, drought has exacerbated conflicts among the pastoral communities and between the pastoralists and their neighbouring, non-pastoralist, communities and national wildlife parks. It also causes food shortages (experienced by about 97.4 %), human health problems (experienced by 89.4%) and animal health problems (experienced by 98% of respondents). There are gender implications of these changes because women have to travel further for water and girl children are sometimes taken out of school to assist; whilst at the same time their food security is affected as the livestock roam further from the home base where the women and children stay.

Pastoralists also mentioned that due to the increasing intensity and duration of drought hazards they are forced to move to new places where they did not go before. Furthermore, at the time of conflicts livestock raiding is very common (Amsalu and Adem, 2009).

Farmers from the study villages in Tanzania mentioned that inadequate water was the major impact of climate change for them. Ibohoro is dependent on irrigation and, until the fall of the National Agriculture and Food Cooperation (NAFCO) in 1978, which owned the rice irrigation farms, drought was not a problem due to the reliable and year-round water supply in village irrigation canals. A subsequent system of rationing water to the village canals to three days per week has been a source of water conflicts in the village. Ikuvala, in contrast, relies on rain-fed agriculture but this has also suffered due to erratic rainfall and drought frequency. Farmers reported during focus group discussions that they rely on hiring irrigable land in nearby villages when droughts strike. However the village has no reliable water sources, and during droughts even groundwater supplies are insufficient so they have to rely on natural springs in the mountains and water supplies in the nearby emerging urban center (Ilula-Mwaya).

5.0 Evidence for responses to climate change

It is important to understand the nature of climate change impacts, key vulnerabilities and adaptation practices at the local level in order to identify and implement appropriate adaptation strategies at community and household levels.

In many instances, “coping” and “adaptation” in the study of climate variability and change, have been used interchangeably, yet the two mean different things. And because of frequent confusion associated with use of the two terms Dazé et al. (2009) outline the following to illustrate the fundamental characteristics between the two: coping is generally short-term and immediate, oriented towards survival, not continuous, motivated by crisis and is reactive, often degrades resource base, and is prompted by a lack of alternatives. On the other hand, adaptation is oriented towards longer term livelihoods security, a continuous process where results are sustained, involves planning, combines old and new strategies and knowledge, and is focused on finding alternatives. In most cases, communities actually use both “adaptation” and “coping” strategies in reducing their vulnerability to climate change. Community members endowed with reasonable resource bases tend to adopt adaption measure much more than those without access to, and control over, resources within the same community. Such individuals therefore resort to a short-term, crisis management, approach hence depleting even further the little resource base they may have. Therefore, it is extremely important to have interventions that will cater for the less privileged community members, especially emphasizing the need for adaptations to changing climate in order to lessen their vulnerability on a long term basis.

In the West African country of Benin, herders largely depend on the sales of livestock and their products to buy main foods and other necessities for the survival of the family (Little and McPeak, 2006). Confronted by various risks such as drought, flood, plant and animal diseases and market shocks, herders cope by collecting and accumulating wild resources, and animal products for meeting their needs like energy, clothing, housing,

health, food and money (Scoones, 1992; Scoones et al., 1996; Scoones and Wolmer, 2003). In the arid and semi-arid regions, drought is part of a normal cycle and pastoralism in these regions has evolved in response to the climatic variability over a long period. It is about adaptation to severe environments characterized by a high spatial and temporal variability of rainfall (Ellis, 1995).

For thousands of years the pastoral communities in south Omo, Ethiopia, have practiced different coping and/ or adaptation strategies against the impacts of localized climate related hazards. Among the most common strategies that the pastoralist are using are selling of short leg livestock (sheep and goats), sharing resources with relatives, use of wild animals and plants which are not normally consumed during good years, mobility, engaging with labour work in the nearby town, and change in food intake (quality, quantity and timing). In recent times, pastoralists have been receiving food aid both from government and non-governmental organizations (NGOs). However, due to increased intensity and severity of the climate change induced hazard, the capacity of these traditional coping and adaptation strategies is limited. Thus, to make the pastoral economic system sustainable and resilient to climate shocks, new adaptation strategies should be implemented together with the traditional mechanisms.

In the South Omo region of Ethiopia about 58% of the respondents have been using one or more of the following adaptation options (with the most common listed first): changing crop varieties (implemented by about 43.3% of the respondents); implementing soil and water conservation strategies (34.6% of the respondents); migrating to safer areas (26.6% of the respondents); planting trees for shade (24%) and irrigation activities such as building flood protection structures, diverting river channels and building water harvesting schemes (24%). On the other hand, the implementation of adaptation practices related to livestock farming is very poor. Only about 13.5% of the respondents used improved animal feeds and changing their livestock varieties and other adaptation options such as diversifying the domestic animals that they keep. Reducing the livestock population and keeping

improved animal herds are also poorly implemented. The most important reason for this lack of implementation is the presence of strong cultural beliefs – livestock is used as a measurement of wealth and status so farmers are actually actively adding more livestock to existing populations. In addition, limited technology in the region means farmers do not have the capacity to use some adaptation options such as improved animal feed preparation and improved animal variety.

“ In the arid and semi arid regions, drought is part of a normal cycle and pastoralism in these regions has evolved in response to the climatic variability over a long period.”

Benin case studies

Agriculture and animal husbandry are the main economic activities in Benin (Eboh et al., 2004; Renard et al., 2004) but are driven by environmental, economic and social parameters and have become very sensitive to the change of climate which has resulted in soil degradation and desertification (Omide and Juma, 1991; McCarthy et al., 2001; Hinvi, 2007; Morton, 2007). In the state of a co-exploitation of productive resources, bloody conflicts are recorded between major actors. For instance, in the last thirty years, conflicts between farmers and herders are the most recurrent in animal production zones involving foreign migrant herders essentially from Burkina-Faso and Niger. These conflicts are about access to fodder and water resources already highly affected by climate change (MEHU, 2004; MAEP, 2007). The aim of one case study was to analyse the adaptation strategies of herders to spatio-temporal variability of water resources in Benin. Given the importance of water, another case study undertook an analysis of the spatial distribution of ground- and surface water resources at four time periods of differing political importance: 1990 (beginning of democracy in Benin), 2000 (commencement of the Millennium Development Goals (MDGs)), and projections to 2015 (end of the MDGs) and 2025 (end point of Benin’s current long term development

strategy). The aim was to link these to national and international policy documents and use a strength-weaknesses-opportunities and threats perspective to analyse the appropriateness and likeliness of goals being reached under climate change. The aim of the third Benin-based study was to determine the feasibility of weather insurance for food and cash crops, and what this should look like in order to appeal to farmers.

Senegal case study

The Senegal case study took place in seven communities (Ndiégué Nianiar, Ndiémane, Thiar, Thiathiao Kaba, Ndiédieng, Gram Fall, Sémbéme) in the ground-nut growing district of Bamey. This district is 120km from Dakar, the capital of Senegal. Located between 14° 42' North and 16°28' West, the groundnut basin covers an area of 1357 km2. It is bordered to the north by the district of Tivaouane, to the east by the district of Diourbel, to the west by the district of Thies, to the southwest by the district of Mbour, and to the south by the Department of Fatick. The aim of the study was to compare observational meteorological records with perception of change in the seven communities in the ground-nut growing district of Bamey. Response strategies were then investigated through participatory rural appraisal exercises.

Nigeria case study

The Nigerian case study focused on seven states (Ekiti, Kogi, Kwara, Ogun, Ondo, Osun, Oyo) in the southwest corridor of the River Niger. This savannah area experiences temperatures between 26 to 32ºC with rainfall of 1000 to 1800mm This area comprises savanna vegetation and lies between latitude 7010' and 8030'N. The surrounding geology is underlain by undifferentiated impervious igneous and metamorphic rocks, meaning that the local population largely relies on rain and surface water (Adekunle et al., 2007; Ayeni, 2012). The cultivation is mainly arable crops such as maize and tubers (Fasona et al., 2007; Alo et al., 2008). The major occupations are farming, trading, artisan and civil services (Alo et al, 2008). The specific objectives of the case study were to evaluate the vulnerability and coping strategies of communities to water stress in the study area; analyse and evaluate the quality and adequacy of domestic supply sources and, lastly, determine the likely implication of climate change on rural water supply sources and its implication on the communities under study.

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In the Kenyan case study, the respondents who indicated that they had perceived climate change in the area were further asked how they had responded to this perceived threat. Pastoralists use multiple adaptation strategies to enhance resilience to perceived climatic changes. This flexibility is key to managing the harsh heterogeneous environment and variable climate in which they operate. Overall, a significant number of pastoralists indicated they have adapted to climate changes by adopting one or more strategies. These include increased sale of livestock, especially shoats; borrowing from relatives during times of drought; participation in cash/food-for-work activities; application of soil conservation schemes; increased and frequent herd mobility and splitting; and keeping different livestock species with an increasing number of camels and shoats. These adaptation strategies employed by pastoral households further give evidence to the diverse livelihood strategies in the arid areas as observed by Opiyo et al. (2012) as well as other studies by Huho et al. (2011). It is important to understand the nature of climate change impacts, key vulnerabilities and indigenous adaptive responses at local levels, so that there may be devised appropriate adaptation strategies at community and farm levels. Information on how communities perceive and adapt to climate variability and change is essential to guide future adaptation strategies and policies. Essentially, improved adaptation to current climate is a step in preparation for longer term climate change.

In Nigeria, the case study was not specifically on pastoralist communities but the adaptation strategies adopted by the rural communities around small-scale water management (rain water harvesting and surface water protection) are also relevant to pastoralist communities. Rain water is the major source of water during the rainy season for all rural population in the study area. Different containers of various sizes were used for harvesting rainwater depending on socio-economic status of the households. Part of the harvested rain was stored and used during the peak dry season. In addition, each of the visited communities had an

indigenous spring, stream or pond owned by an individual clan or group of clans. The values placed on any available surface water make its protection and maintenance unique based on simple indigenous knowledge. Depending on culture/tradition, the methods varies from one locality to another. For example, in Akoko Region and its environs, the spring environment is cleared and cleaned and a solid concrete wall is built around the spring to prevent dirty, debris and other solid materials from polluting it (Ayeni 2010). Stones and fine sand particles are spread around some springs while restrictions are placed at the entrance of others to prevent peoples' legs touching the water. Some springs are also housed with a dispensing outlet through the wall (Ayeni, 2010) The rural dwellers in the Nigerian study area survive water scarcity mostly through searching, rationing, and storage amongst others during the peak dry season. Searching implies sourcing for water wherever is available, even outside one's community and in most cases, it requires a long trek. In the case of rationing, individuals or households are allowed to access a water source and fetch water based on an agreed community arrangement. This may be on an hourly or daily rate depending on the yield capacity of the water source in question. Rain harvesting and storage is yet another mechanism common among rural dwellers. According to the respondents, the little stored water could sustain the household for few weeks after the rains. Others include the use of sachet water by a few people who visit town on daily basis. This is quite rare among the rural dwellers as water quality is not their problem rather quantity and affordability.

" The values placed on any available surface water make its protection and maintenance unique based on simple indigenous knowledge."

IZimbabwe case study

The field study was conducted in two districts of Zimbabwe - Seke and Murewa. Both districts are in the Mashonaland East province in Zimbabwe. Seke district is located 23km south of Harare while Murewa district is located 81.5km north-east of Harare. Seke district has a population of 77 840 people and 18 854 households while Murewa has a population of 162 660 people and 37 152 households. Seke district has a total of 75 080ha with 36 808ha in region IIA (CSO, 2004). Climate variability induced hazards include droughts, floods and tropical storms. Zimbabwe has been prone to climate variability particularly droughts and violent storms. Some parts of Zimbabwe have also been hit by floods but the area under study has been more prone to droughts and violent storms. Thus this study excluded floods and focused on droughts and violent storms only. The objective of the research in Zimbabwe was to understand the major factors that contribute to heterogeneity across households and across sites and to understand how different households respond to climate variability induced hazards.

6.0 Indigenous knowledge systems

Indigenous Knowledge Systems (IKS) are defined as learned ways of knowing and looking at the world (MacClure, 1989). Warren (1991) refers to them as traditional and local knowledge existing within, and developed around, specific conditions of women and men indigenous to a particular geographic area in contrast with knowledge generated within the international systems of universities, research institutes and private firms. They have evolved from years of experience and trial-and-error problem solving by groups of people working to meet the challenges they face in their local environments, drawing upon the resources they have at hand. Generally, IKS affects the well-being of the majority of the people in the developing countries (Ngulube, 2002); some 80% of the world's population depends on IK to meet their medical needs, and at least half rely on indigenous knowledge, crops and food supplies (CSOPP, 2001, Rubaihayo, 2002; Aly and Hamado, 2005). IKS are recognised as important for sustainable development in Africa (e.g. Ulluwishewa, 1993; Dewalt, 1994;

Makara, 2002; Ngulube, 2002).

IKS is not restricted to the pastoralist communities of Ethiopia, Kenya and Tanzania already discussed – research amongst crop farmers in the Lake Victoria Basin in Uganda uncovered that traditional and indigenous knowledge is used as adaptation options and coping strategies to meeting challenges of climate variability and change in that area. These include early/timely planting of seeds/crops immediately after receiving the first rain of a planting season; planting root crops (e.g. cassava, yams, sweet potatoes) capable of withstanding long dry spells; planting early maturing crop varieties; crop irrigation using water harvested from roof tops and ponds; application of manure (e.g. cow dung) and mulching the soil to retain moisture and improve soil conditions. Others include planting trees; water harvesting for animal use and crop irrigation; opening up virgin lands for crop production; crop rotation; "punishing rain makers" in case the rains are delayed in a given season; cultivating in wetlands to get adequate moisture for crops; planting trees in gardens; terracing; proper storage of harvests; digging water ways to prevent flooding; growing more coffee to sustain livelihoods; digging wells to provide water; burying of weeds to form organic manure, and setting up retail businesses/shops to secure livelihoods in case crop harvests fail. These findings clearly demonstrate that IKS of local communities have some positive aspects to offer and if used well, can augment scientific knowledge as has been argued by Dewalt (1994).

6.1 Constraints of indigenous knowledge systems

Unlike scientific knowledge, indigenous knowledge is not transferable across time, space and social setting (Dewalt, 1994) and even though (or even because) it is very rich in contextual detail, it is immobile, having little utility outside particular places (Kloppenburg, 1991). Much as local people are found to have a stock of indigenous knowledge, many of them acting as good indicators for local climate forecasting, the main problem remains how to standardize their meanings to cater across all cultural boundaries to mean the same thing. In many cases, an indicator (e.g.

singing of a bird) in one area does not necessarily mean the same thing in another, and the language of description can even impede intra-community interpretations (Roncoli et al., 2010; 2011; Kihupi et al., 2003). Likewise, whilst IKS may have proven effective in promoting sustainable development in Africa, most of the traditional coping and adaptation mechanisms used over several decades are losing efficacy owing to socio-economic, political, ecological and environmental changes. In the context of a changing climate, many strategies end up being reactive coping and ultimately unsustainable.

For example, coping strategies such as opening up virgin lands for crop production each planting season and cultivating in wetlands to get adequate soil moisture for crops are just crisis driven actions aimed at survival. Simply put, IKS on its own is not enough. It is suggested that a blend of approaches and methods from science and technology and from traditional knowledge opens avenues towards better disaster prevention, preparedness, response and mitigation.

7.0 Factors affecting responses to climate change

There are a number of interrelated factors that affect the willingness and ability of communities to adopt and implement various adaptation strategies. The factors outlined below are taken largely from the Ethiopian and Kenyan case studies amongst pastoralists and backed up by the wider literature.

a) Perceptions of climate change and variability

As has already been discussed, whether or not there are responses to climate change depend on the perception that climate change is occurring, and by virtue of alterations to which parameters. In the Ethiopian case study, increased perception of temperature changes positively and significantly affects pastoralist use of adaptation strategies. It has a significant and positive impact on changing crop varieties and soil and water conservation practices. Perception of the rainfall change and variability enhances pastoralists' decision to implement soil and water

conservation practices; planting trees for shading and the use of irrigation. The duration of the change affects the likelihood of a response: increased rainfall in one year (the short term) means that communities do not feel it is necessary to adopt strategies for adapting to drier conditions (over the long term).

b) Household characteristics

Level of education

Analysis of results from the Ethiopian case study indicate that the level of education of the household head increases the probability of that household adapting to climate change. This is true for all adaptation options investigated, except for the option of migrating to a safer place. In the case of the latter, pastoralists' with better education may use other alternatives, rather than migrating to other areas. This is consistent with other survey results (Deressa et al., 2011) that showed that households with higher level of education are more likely to take measures to adapt to climate change. In the Kenyan case study, it is argued that in rural farming households, the education level of the farmer enables them to access information and technologies and adoption of improved technologies to exploit changing climate.

Household size

In the Ethiopian case study, for most of the adaptation methods, increasing household size significantly increases the probability of adaptation to climate change, except for soil and water conservation and use of irrigation. For extensive livestock production systems such as the Turkana's in Kenya, larger households are normally associated with higher labour endowments, which is key for large livestock herds held by pastoralists.

Gender of the head of household

The results of the Ethiopian case study show that male-headed households are more likely to adapt than female-headed households. This is because male-headed households are more likely to get information about new technologies than female-headed households (Hassan and Nhemachena, 2008). On the other hand, women have limited access to information, land and other resources due to traditional social barriers (Deressa et al., 2009). However, in the pastoral area, since women are responsible for crop farming, the soil and water conservation practices are highly

implemented by the female-headed households. Therefore, the adoption of new adaptation methods may be implemented either by male- or female-headed households depending on the context.

c) Farming characteristics

Farmsize

Research in Ethiopia has shown that the size of the farm is very important in determining the extent to which adaptation strategies are adopted and implemented. Farmers with access to larger farmers are more likely to use adaptation strategies such as planting of different crop varieties; soil and water conservation methods and irrigation schemes.

Livestock ownership

Studies (e.g. Silvestri et al., 2012) have demonstrated that livestock are particularly important for increasing the resilience of vulnerable, poor households, who are subject to climatic and disease shocks through spreading risk. Results of the research in Ethiopia show that livestock ownership has positively affected pastoralists' options to adopt any one of the adaptation options. Livestock ownership significantly increases the likelihood of using soil and water conservation practices and migrating to a safer area. In the Kenyan case study, ownership of livestock producing milk was observed to be associated with climate change adaptation. This is coherent with the fact that having milk allows the pastoral households to feed themselves and they can also sell surplus to meet other family needs. The livestock kept for milk by the Turkana are cattle, goats and camels. Other studies by Fratkin et al. (2011) and Silvestri et al. (2012) have also reported that lactating herds are essential resources for coping and adapting to climate stress in the ASALs, where the majority of livelihoods are livestock based. Furthermore, the results suggest that households with a high proportion of lactating herd are more likely to show increased resilience to extreme climate events like drought, especially where they practice mobility, than households with small herd size. Studies by McPeak and Little (2005) also revealed that livestock keepers had more milk available for home consumption where they derived a higher share of their income from livestock production.

Total farm income

In the Ethiopian case study, an increase in total income generated from farming activities does have positive and significant effects on pastoralists' options to plant trees for shading and migrating to safer areas. In Kenya, other significant determinants of adaption, such as cash remittances from relatives and friends, allow households to purchase essential food items instead of relying on relief food aid. In this case study, farm income was also identified as a positive and significant impact variable on the likelihood that the household will adapt.

d) Institutional factors

Access to climate information

Increasing access to weather forecasts and climate information has a positive and statistically significant impact on the adoption of any of the adaptation practices in the Ethiopian case study. Access to climate information significantly increases the likelihood of changing crop varieties and planting trees for shade. Media and extension services are important means of information dissemination on agronomic practices as well as on climate change adaptation. For the peripheral areas where radio, television and telecommunication services are poor, information exchange using local development extension agents is found to be an important mechanism.

Access to farm extension services

Increasing the access of farmers to extension service has a positive and significant effect on the pastoralists in the Ethiopian case study to use adaptation practices. Increased extension services significantly enhances the use of irrigation and planting trees for shade as adaptation strategies. To a lesser degree, it also has a positive effect on changing crop varieties and soil and water conservation practices.

Access to credit

There are contradictory results around whether or not access to credit has a positive or negative impact on the uptake of adaptation. On the one hand, the existing literature argues that access to credit is a significant determinant of household climate adaptation in that it allows households to purchase items for diversified livelihood during climatic stress (Knowler and Bradshaw, 2007). On the other hand, results of the Ethiopian case study show a negative impact on most of

the adaptation practices. Credit access has a negative and significant impact on the use of irrigation and planting trees for shading as adaptation strategies. However, it has a positive effect on soil and water conservation adaptation strategies, but both are not statistically significant.

Distance to market

In the literature, proximity to livestock markets has a strong positive association with household adaptation to climate change. Some research studies (e.g. Kirkbride and Grahn, 2008) have shown that proximity to commercial markets increases the likelihood of adaptation, while isolation increases pastoralists' vulnerability to climate change and variability. In the Ethiopian case study, increasing distance to market to sell products or buy farm inputs had a significant negative effect on the use of irrigation and planting trees for shading. In contrast, key informant interviews in the Kenyan case study research revealed that pastoralist households around small urban centres were perceived to be more vulnerable to climate variability unlike their counterparts in remote locations in the study area. The reason for this perception may be that when livestock is transformed into cash, the money obtained is quickly dissipated by many household needs without re-investing into productive enterprises.

8.0 Recommendations

Based on the results from Kenya, Ethiopia, Uganda, Senegal, Tanzania, Zimbabwe, Benin and Nigeria, a number of recommendations can be made to further support adaptation. These can additionally be divided into direct recommendations (where the outcomes themselves enable adaptation), and indirect recommendations (where the outcomes enable and improve the likelihood of the direct recommendations being effective). The following recommendations are generated for policy formulation, the introduction of new adaptation strategies, for strengthening good practices and for informing the conduct of further research. The analysis of water management in Benin highlighted the importance of national policies being developed that take climate change into account. The imperative of support and enabling of adaptation is highlighted by the fact that in Bambey, Senegal,

the only response strategy that is deemed effective is migration from rural areas to urban ones.

8.1 Direct recommendations

Provide improved weather and climate information

In order to enhance the adaptive capacity of communities to deal with climate variability and change, the community members should not only be made aware of the available scientific information concerning current and future climate information related to livelihoods but their capacity to use this information effectively should also be built. In Ethiopia, Kenya and Uganda the availability and accessibility of weather and climate information can enable more effective and proactive decision-making that decreases climate risk. However, the nature of available information needs to change to better suit farmer and pastoralist needs: in Ethiopia total monthly or seasonal rainfall amounts are unable to capture the rainfall characteristics (changes in the number of wet and dry day; number of wet and dry spells; onset and cessation times) which are very important for agricultural activities. Unfortunately, lack of funding, and inadequate capacity are frequently cited as reasons hampering government funded agents for not carrying out sensitisation programs; while for most NGOs or CBOs (community based organizations), climate change related issues are simply not their main current focus.

Introduce new technologies

In certain instances, new technologies would greatly enhance the adaptive capacity of communities, although the manner in which this is undertaken is important to ensure understanding and buy-in from the target communities. It is well known by the local development agents that it is hard to introduce new technologies or to implement new adaptation strategies in the South Omo communities in Ethiopia, but they can accept and implement new technologies if there is continual training and demonstration. Since the Dasenach and Nyangatom pastoralists of Ethiopia are now unable to carry out flood recession agriculture along the Omo River, new technologies such as a water pump and small water diversion schemes should be introduced for them to be able to include irrigation

in their adaptation activities. For crop farmers in Zimbabwe, drought tolerant crops; drought resistant crops and livestock breeds or short season varieties will also enable adaptation.

Provide weather insurance

The study in Benin showed that the legal and institutional environment is very favourable for the use of weather insurance as a mechanism of spreading risk and reducing vulnerability to climate change. A pilot project is in place that is a partnership between various government offices (including the National Office for Agricultural Support and the National Directorate of Insurance) and both national and international private sectors partners. At grassroots level opinion is mixed: some see weather insurance as an effective means of income protection, whilst others fear that it is a scam. The particular circumstances for weather insurance is dependent on the context: in Benin it would need to cover both food and cash crops, including corn, sorghum and cotton; and the minimum contract would need to be for at least a year with affordable quarterly premiums.

Provide support to recognised adaptation strategies

Since livestock are a key resource in the pastoralist case studies in Ethiopia and Kenya, extension services on veterinary services, planting fodder varieties, rehabilitation of degraded areas, rangeland management and area enclosures are encouraged. As outlined above, weather information is also necessary to enable them to make strategic decisions on challenges that affect their wellbeing. Livelihood diversification is a well-recognised adaptation strategy. Supporting the introduction of new animals, such as camels in the South Omo lowlands of Ethiopia, enables adaptation since evergreen bush and shrubs for them is always available, and they can tolerate the chronic water problems in the region and provide a large volume of milk. Petty trading and ox and sheep fattening are activities that that should be supported. Farmers in the Zimbabwean case study are highly dependent on agriculture as a source of income but with more frequent droughts they are likely to realize less income. Diversification into non-agricultural income sources would spread risk and reduce the likelihood of adverse effects of climate on their

livelihoods. Improved awareness and training, for example through awareness campaigns, will also support robust adaptation strategies, as highlighted in the Nigerian case study in the context of sustainable water management. Financial constraints for income diversification can be solved by providing credit with a low interest rate.

Solve chronic water problems

Water availability is a key constraint on both crop and livestock farmers, and projected to change with climate change. Opportunities for irrigation in Ethiopia's pastoral communities would reduce a major source of conflict, as well as improve gender equality by lessening the work burdens for women. In Nigeria, catchment management through reforestation (using species that are climate-resilient and locally appropriate) can better regulate water cycling and availability (Merrey et al., 2005). Culturally-important trees in sacred forests particularly require protection due to their roles in protecting tropical environment water catchments through their densely canopy (Russell-Smith et al., 2007). In addition, they could strengthen local's economy based on their economic value.

8.2 Indirect recommendations

Improve access to credit

As mentioned above, the Ethiopian research has shown that providing credit for the poor pastoral communities has multiple advantages including the fact that it enables community members to engage in off-farm activities like petty trade, livestock fattening and dairy in order to diversify their income. Furthermore, access to credit can contribute to food security and household asset building which, in turn, increases the socio-economic adaptive capacity of the poor pastoral households.

Develop infrastructure to enable improved communication

Rural communication, in terms of road networks, local radio broadcasts and wireless telecommunication should be strengthened for easy and fast information transfer. This would enable improved communication of weather and climate information or information around different adaptation strategies, described above as being very important. It would also allow farmers to better access markets with better prices for inputs and credit among others as this

will, in-turn, improve adaptive capacity. This recommendation arose strongly from the Ethiopian and Zimbabwe case studies.

Strengthening communities' resource management

Most rural communities have historically developed adaptation mechanisms to deal with water-related stress and scarcity problems (Tompkins et al., 2010; Njoh, 2002; Fonchingong and Fonjong, 2003). In Nigeria, the community head, elders and Community Development Association's (CDA) function is to regulate and manage water sources in the immediate environment with various respected norms and customs. Ideally, this plays a crucial role in ensuring collaborative dialogue to enable equal water usage and conservation measures at the water source location. Empowering such local institutions is an option that promotes sustainable adaptation mechanisms and reduces the need for direct government interventions.

A participatory approach allows the communities' stakeholders to collectively share their viewpoints and interest in through free and equal communication. It is expedient that there is no periodic discharge and water quality data but the trend of situation had been passing from one generation to another through historical discussion (physically, socially, and culturally about the past) with respect to functions performed by communities' stakeholders - the heads, elders, and CDAs.

9.0 Conclusion

The paper has synthesised case study findings of research in 8 countries from across the African continent: Ethiopia, Kenya, Tanzania, Uganda, Senegal, Benin, Nigeria and Zimbabwe. Each case study had different aims and objectives (box 1), but broadly speaking all were investigating aspects of climate change adaptation. Findings across the case studies show that perceptions of change in temperature and precipitation parameters are widely perceived by farmers and fishers in the case study communities and, by and large (although not always exactly), these perceptions match the reality as from the observational records. Although climate change is not the only driver of change in livelihoods, there have been significant impacts of this change in climate. A wide variety of responses have

been observed in light of the changing conditions, although access and availability of these varies with household characteristics, farming characteristics and the institutional framework.

A variety of recommendations are made in order to ensure the sustainability of responses and, in particular, to encourage sustainable adaptation as opposed to mere coping. These recommendations are likely to be enabled by policies. They are both direct; for example improving access to weather and climate information, transferring technologies, providing access to micro-insurance, supporting existing effective adaptations, and addressing water conflict; and indirect (or win-win development situations), such as improving access to credit, improving the availability of infrastructure for communications, and strengthening existing community resource management mechanisms.

10. References

Adger, N., Agrawala, S., Mirza, M. M. Q., Conde, C., O'Brien, K., Pulhin, J., Pulwarty, R., Smit, B. and Takahashi, T., 2007, Assessment of adaptation practices, options, constraints and capacity, In Parry, M. L., Canziani, O. F., Palutikof, J. P., van der Linden, P. J. and Hanson, C. E. (eds), Climate Change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK, 717–743.

Adekunle, I. M., Adetunji, M. T., Gbadebo, A. M. and Banjoko, O. B., 2007, Assessment of Groundwater Quality in a Typical Rural Settlement in Southwest Nigeria, International Journal of Environmental Research and Public Health, 4 (4), 307-318

Adnew, M. and Asfaw, B., 2006, Flood hazard assessment in the Ghibe-Omo basin: The case of 2006, Climate change and environmental degradation report on the 2006 flood disaster in Ethiopia, Forum for Environment, Ethiopia between the sharp scissors, Kelbesa Ensermu (Ed.).

Aly, O. and Hamado, S., 2005, Indigenous innovation in farmer-to-farmer extension in Burkina Faso, IK Notes No. 77. http://www.worldbank.org/afr/ik/iknt77.html

Alo, O. A., Raruna, O. J. and Suleiman, Y., 2008, The Health Implications of Retirement: Empirical Evidence from Akoko Area of Ondo State-Nigeria, Pakistan Journal of Social Sciences, 5 (8), 722 – 733.

Amsalu, A. and Adem, A., 2009, Assessment of climate change-induced hazards, impacts and responses in the southern lowlands of Ethiopia, Forum for Social Studies, Addis Ababa.

Ayeni, A. O., 2010, Spatial Access to Domestic Water In Akoko Northeast LGA, Ondo State, Nigeria, Unpublished Ph.D. Thesis, University of Lagos, Lagos, Nigeria

Ayeni, A .J., 2012, Achieving quality and standards in the management of Nigerian secondary schools: policy goals, current practice, trends, challenges and opportunities, International Journal of Research Studies in Management, 37-45.

Balme, M., Galle, S. and Lebel T., 2005, Démarrage de la saison des pluies au Sahel: variabilité aux échelles hydrologique et agronomique, analysée à partir des données EPSAT-Niger, Sécheresse, 16 (1).

Bewket, W. and Alemu, D., 2011, Farmers' perceptions of climate change and its agricultural impacts in Ethiopia, Ethiopian Journal of Development Research, 33, 1–28.

Bewket, W., 2012, Climate change perceptions and adaptive responses of smallholder farmers in central highlands of Ethiopia, International Journal of Environmental Studies, 69 (3), 507–523. doi.org/10.1080/00207233.2012.683328.

Bryan, E., Ringler, C., Okoba, B., Roncoli, C., Silvestri, S. and Herrero, M., 2013, Adapting agriculture to climate change in Kenya: Household strategies and determi nants, Journal of Environmental Management, 114, 26-35.

Central Statistics Office (CSO), 2004, Provincial profile Mashonaland East, Harare, Zimbabwe.

Civil Society Organisations and participation Programme (CSOPP), 2001, Conserving indigenous knowledge: integrating new systems of integration, UNDP.

Dazé, A., Ambrose, K. and Ehrhart, C., 2009, Climate Vulnerability and Capacity Analysis Handbook, 1st Edition, Care International, USA.

Deressa, T. T., Hassan, R. M, Ringler, C., Tekie, A. and Mahmud Y., 2009, Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia, Global Environmental Change, 19, 248-255.

Deressa T., Hassan, R. and Ringler, C., 2011, Perception of and adaptation to climate change by farmers in the Nile basin of Ethiopia, Journal of Agricultural Science, 149, 23–31.

Dewalt, B. R., 1994, Using indigenous knowledge to improve agriculture and natural resource management, The Society for Applied Anthropology, 53, 123-131.

Eakin, H., 2005, Institutional change, climatic risk, and rural vulnerability: Cases from central Mexico, World Development, 33 (11), 1923-38.

Eboh, E. C., Oji, K. O., Oji, O. G., Amakom, U. S. and Ujah, O. C., 2004, Towards the ECOWAS Common Agricultural Policy Framework: Nigeria Case Study and Regional Analysis, African Institute for Applied Economics, Enugu, Nigeria. 197 p.

Ellis, J., 1995, New Directions in Pastoral Development in Africa, in Scoones I (Ed.) Living with Uncertainty, Intermediate Technology, London, 37–46.

Eriksen, S. and Silva, J. A., 2009, The vulnerability context of a savanna area in Mozambique: House-

hold drought coping strategies and responses to economic change, Environmental Science and Policy, 12, 33–52.

Fasona A. S., Omolayo, F. O., Falodun, A. A. and Ajayi, O. S., 2007, Granite Derived Soils in Humid Forest of Southwestern Nigeria - Genesis, Classification and Sustainable Management, American-Eurasian Journal of Agricultural and Environmental Sciences, 2 (2), 189 – 195.

Fonchingong, C. C. and Fonjong, L. N., 2003, The concept of self-reliance in community development initiatives in the Cameroon grassfields, Nordic Journal of African Studies, 12 (2), 196–219.

Fratkin, E., Nathan, M. and Roth, E., 2011, Seeking alternative livelihoods in Northern Kenya: Costs and benefits in health and nutrition, Paper presented at the International Conference on the Future of Pastoralism, 21- 23 March 2011.

Garba, I., 2012, Impacts des changements climatiques sur quelques secteurs clés: impacts sur le pastoralisme, In Le Sahel face aux changements climatiques: Enjeux pour un développement durable,Centre Régional, AGRHYMET, Niamey, Niger, Bulletin Mensuel, Numéro special, 29.

Government of Kenya, 2008, Constituency Report on Well-Being in Kenya, The constituencies are Turkana Central, Turkana South, North Horr, Saku, Wajir North, Wajir South, Mandera Central, Turkana North, Mandera East, Garsen, Galole, Wajir West, Samburu West, Mandera West, Laisamis, Wajir East, Dujis and Ijara.

Guèye, M. and Sivakumar, M. V. K., 1992, Analyse de la longueur de la saison culturale en fonction de la date de début des pluies au Sénégal. Compte rendu des travaux n° 2. Niamey (Niger), Centre sahélien de l'ICRISAT.

Haile, M., 2005, Weather patterns, food security and humanitarian response in sub-Saharan Africa, Philosophical Transactions of the Royal Society B, 360, (1463), 2169–2182.

Hassan, R. and Nhemachena, C., 2008, Determinants of African farmers' strategies for adapting to climate change: multinomial choice analysis, African Journal of Agricultural and Resource Economics, 2, 83–104.

Hinvi, C. J., 2007, Adaptation de l'itinéraire technique de production du riz aux changements climatiques au Nord-Ouest du Bénin. Les stratégies d'adaptation et études de cas, Conférence Régionale sur les Changements Climatiques et les Phénomènes Extrêmes en Afrique Sub-saharienne: Impact sur les ressources naturelles, enjeux pour la recherche et la decision, Centre International des Conférences de Cotonou, Résumé des communications, 40p.

Huho, J., Ngaira, J. K. and Ogindo, H. O., 2011, Living with drought: the case of the Maasai pastoralist of Northern Kenya, Educational Research, 21(1), 779 – 789.

Huq, S., Reid, H., Konate, M., Rahman, A., Sokona, Y. and Crick, F., 2004, Mainstreaming adaptation to climate change in Least Developed Countries (LDCs), Climate Policy, 4, 25–43.

IPCC, 2007, Climate Change (2007): Synthesis Report, Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, IPCC, Geneva.
IPCC, 2012, Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change, In C. B. Field, V. Barros, T. F. Stocker, D. Qin, D. J. Dokken, K. L. Ebi, M. D. Mastrandrea, K. J. Mach, G.-K. Plattner, S. K. Allen, M. Tignor, and P. M. Midgley (eds.), Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp.

Kirkbride, M. and Grahn, R., 2008, Survival of the fittest: pastoralism and climate change in East Africa, Oxfam Briefing Paper 116, Oxfam International, Oxford.

Kihupi, N., Kingamkono, R., Dihenga, H., Kingamkono, M. and Rwamugira, W., 2003, Integrating indigenous knowledge and climate forecasts in Tanzania, In C. Vogel and K. O'Brien (eds),

Coping with climate variability: the use of seasonal climate forecasts in Southern Africa, Ashgate, Burlington, VT, 155–169.

Knowler, D. and Bradshaw, B., 2007, Farmers' adoption of conservation agriculture; a review and synthesis of recent research, Food Policy, 32 (1), 25-48.

Kurukulasuriya, P. and Mendelsohn, R., 2006, A Ricardian analysis of the impact of climate change on African cropland, Centre for Environmental Economics and Policy in Africa (CEEPA), Discussion Paper No. 8., University of Pretoria, Pretoria, 58 pp

Lejju, J. B., 2012, A mid- to late-Holocene Vegetation Dynamics in Lake Victoria Basin: Evidence from Phytolith Analysis, Quaternary International, DOI: 10.1016/j.quaint.2012.08.706

Little, P. D. and McPeak, J. G., 2006, Pastoral Livestock Marketing in Eastern Africa: Research and Policy Challenges, in J. G. McPeak and P. D. Little (eds), Intermediate Technology, Rugby, UK, 1-13.

MAEP, 2007, Point Transhumance Transfrontalière de 1995 à 2007, Ministère de l'Agriculture, de l'Elevage et de la Pêche (MAEP)/CeRPA Borgou/Alibori, République du Bénin.

Makara, M., 2002, Management of indigenous knowledge in Lesotho, in R. Snyman (ed.), CECSAL (2002): From Africa to the World – the globalization of indigenous knowledge systems, Proceedings of the 25th Standing Conference of Eastern, Central and Southern African library and Information Association, 15-19 April, Caesars Gauteng Conference Centre, South Africa, Pretoria LIASA, 37-47.

McCarthy, J. J., Canziani, O. F., Leary, N. A., Dokken, D. J. and Kasey, S. W., 2001, Climate Change 2001: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the IPCC Third Assessment Report, Cambridge, UK, Cambridge University Press. 1032p.

MacClure, G., 1989, Introductory remarks, In Warren, D. M., Slik-

kerveer, L. J. and Tilitola, S.O. (eds), Indigenous knowledge systems: Implications for agriculture and international development, Studies in Technology and Social Change, No.11, Ames, Iowa State University.

McPeak, J. and Little, P. D., 2005, Cursed if you do, cursed if you don't: The contradictory processes of pastoral sedentarization in Northern Kenya, in E. Fratkin and E. A. Roth (eds.), As Pastoralists Settle, New York, Kluwer Academic Publishers, 87 - 104.

MEHU, 2011, Deuxième Communication Nationale de la République du Bénin sur les Changements Climatiques, 165p. MEHU, 2004, Stratégie nationale de Mise en Œuvre de la Convention-Cadre des Nations Unies sur les Changements climatiques (SNMO-CCNUCC), Ministère de l'Environnement, de l'Habitat et de l'Urbanisme (MEHU), Cotonou, République du Bénin. 81p.

Merrey D. J., Drechsel, P., Penning de Vries, F. W. T. and Sally, H., 2005, Integrating 'livelihoods' into integrated water resources management: taking the integration paradigm to its logical next step for developing countries, Regional Environmental Change, 5, 197–204.

Meze-Hausken, E., 2004, Contrasting climate variability and meteorological drought with perceived drought and climate change in northern Ethiopia, Climate Research, 27, 19–31.

Morton, J. F., 2007, The impact of climate change on smallholder and subsistence agriculture, Proceedings of the National Academy of Sciences, 104 (50), www.pnas.org/cgi/doi/10.107/pnas.0701855104

Ngulube, P., 2002, Strategies for managing and preserving indigenous knowledge in the knowledge

management era: challenges and opportunities for information professionals, Information Development, 18 (2), 95-100.

Njoh, A., 2002, Barriers to Community Participation in Development Planning: Lessons from the Mutengene (Cameroon) Self-help Water Project, Community Development Journal, 37 (3), 233–248.

Nkedianye, D., de Leeuw, J., Ogutu, J. O., Said, M. Y., Saidimu, T. L., Kifugo, S. C., Kaelo, D. S. and Reid, R. S., 2011, Mobility and livestock mortality in communally used pastoral areas: the impact of the 2005-2006 drought on livestock mortality in Maasailand, Pastoralism: Research, Policy and Practice, 1, 17

Odada, O., Olago, D., Kulindwa, K., Ntiba, M. and Wandiga, S., 2004, Mitigation of environmental problems in Lake Victoria, East Africa, Ambio, 33, 13-23.

Ogutu, J. O., Piepho, H. P., Dublin, H. T., Bhola, N. and Reid, R. S., 2007, El Niño-Southern oscillation, rainfall, temperature, and normalized difference vegetation index fluctuations in the Marae Serengeti ecosystem, African Journal of Ecology, 46, 132-143.

Omide, S. H. and Juna, C., 1991, A Change in Weather, African Centre for Technology Studies Press, Nairobi.

Opiyo, F. E. O, Wasonga, O. V., Schilling, J. and Mureithi, S. M., 2012, Resource-based conflicts in drought-prone Northwestern Kenya: The drivers and mitigation mechanisms, Wudpecker Journal of Agricultural Research, 1 (11), 442 – 453.

Rao, K. P. C., Ndegwas, W. G., Kizto, K. and Oyoo, A., 2011, Climate variability and change: Farmer perceptions and understanding of the Intra-seasonal variability in rainfall and associated risk in semi-arid Kenya, Experimental Agriculture, 47 (2), 267–291. Doi:10.1017/S0014479710000918.

Reid, P. and Vogel, C., 2006, Living and responding to multiple stressors in South Africa, Glimpses from KwaZulu-Natal, Global Environmental Change, 16 (2), 195−206 .

Renard, J. F., Cheikh, L., Knips, V., 2004, L'élevage et l'intégration régionale en Afrique de l'Ouest, Ministère des Affaires étrangères, FAO-CIRAD, 37 p .

Roncoli, C., Orlove, B. and Kabugo, M., 2010, Indigenous Knowledge in Southern Uganda: the multiple components of a dynamic regional system, Climate Change, 100, 243-265
.
Roncoli, C., Benjamin, S., Orlove, B., Kabugo, M. and Waiswa, M., 2011, Cultural styles of participation in farmers' discussions of seasonal climate forecasts in Uganda, Agriculture and Human Values, 28, 123-138
.
Rubaihayo, E. B., 2002, Uganda: The contribution of indigenous vegetables to household food security, IK Notes No. 44, Africa Region's Knowledge and Learning Center, 4pp
.
Russell-Smith, J., Djoeroemana, S., Maan, J. and Pandanga, P., 2007, Rural livelihoods and burning practices in savanna landscapes of Nusa Tenggara Timur, Eastern Indonesia, Human Ecology, 35 (3), 345–359.

Sarr, B., Kafando, L. and Atta, S., 2011, Identification des risques climatiques de la culture du maïs au Burkina Faso, International Journal of Biological and Chemical Sciences, 5 (4), 1659-1675
.
Scoones, I., 1992, Coping with drought: responses of herders and livestock in contrasting savanna environments in Southern Zimbabwe, Human Ecology, 20 (3), 293-314
.
Scoones, I., Chibudu, C., Chikura, S., Jeranyama, P., Machaka, D., Machanja, W., Mavedzenge, B., Mombeshora, B., Maxwell, M., Mudziwo, C., Murimbarimba, F. and Zirezera, B., 1996, Hazards and Opportunities; Farming Livelihoods in Dryland Africa: Lessons from Zimbabwe, Zed, London.
Scoones, I. and Wolmer, W., 2003, Introduction: Livelihoods in crisis. Challenges for rural development in southern Africa, Institute of Development Studies (IDS), Bulletin 34, 1–14.

Sida, 2004, Strategy for Swedish support to the Lake Victoria Basin, Regeringskansliet.
Silvestri, S., Bryan, E., Ringler, C., Herrero, M. and Okoba, B., 2012, Climate change perception and adaptation of agro-pastoral communities in Kenya, Regional Environmental Change, 12 (4), 791 - 802.

SMUWC, 2001, Baseline Report, Annex 1 of the Final Report of the Sustainable Management of the Usangu Wetland and its Catchment (SMUWC) project, Phase 1, Directorate of Water Resources, Ministry of Water, Government of Tanzania, The SMUWC Project, Mbeya Region, Tanzania. pp 145.

Somé, L. and Sivakumar, M. V. K., 1994, Analyse de la Longueur de la Saison Culturale en Fonction de la Date de Début des Pluies au Burkina Faso, INERA, ICRISAT, Ouagadougou.

Tompkins, E. L, Adger, W. N., Boyd, E., Nicholson-Cole, S., Weatherhead, K. and Arnell, N., 2010, Observed adaptation to climate change: UK evidence of transition to a well-adapting society, Global Environmental Change, 20, 627–635.

Ulluwishewa, R., 1993, Indigenous Knowledge, National IK Resource Centers and Sustainable Development, Indigenous Knowledge and Development Monitor, (3), 11-13.

Verschuren, D., Johnson, T. C., Kling, H. J., Edgington, D. N., Leavitt, P. R., Brown, E. T., Talbot, M. R. and Hecky, R. E., 2002, History and timing of human impact on Lake Victoria, East Africa, Proceedings of Royal Society of London, 269, 289-294.

Warren, D. M., 1991, Using indigenous knowledge in agricultural development, World Bank discussion paper No. 127, Washington DC, The World Bank.

Ziervogel, G. and Taylor, A., 2008, Feeling stressed: Integrating climate adaptation with other priorities in South Africa, Environment, 50 (2), 33−41.

Africa Climate Change Fellowship Program (ACCFP)
Institute of Resource Assessment
University of Dar es Salaam
P.O Box 35097
Dar es Salaam,
Tanzania

accfp@ira.udsm.ac.tz
accfp2@gmail.com

www.accfp.org

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